Red Rock Canyon National Conservation Area

Resource Conservation Workshop

S U M M A R Y

Introduction:

The following is a summary of the discussions concerning resource conservation specific to the Red Rock Desert Learning Center in Las Vegas, Nevada that took place during a 3-day workshop located at the Hillel Foundation in Tucson, Arizona from October 11-13, 2004. The entire workshop was recorded via microphone and videotape.

Summary:

The following is a list of resource conservation strategies/methodologies that were discussed as appropriate for the Red Rock Desert Learning Center:

- The indoor environment of the facility will be designed to meet ASHRAE standard 62 though it need not be operated to that standard
- The facility will utilize a total of 8.5kWh/sf for lighting, plug loads, thermal needs, domestic hot water production, and cooking
- The facility will limit its use of water to 50 gallons per person per day
- The different buildings will represent different primary design strategies:

Dorms	Partial earth integration/earth roof
Flex-Labs & Research	Raised insulated boxes w/ movable insulation
Dining/Kitchen	Night-sky radiation
Administration	Shade – 'Sombrero' strategy
Instructor Housing	Earth integration

- GLHN will perform a life-cycle cost analysis comparing a centralized evaporative chiller, a centralized air-cooled system, and individual package units over 25 years. Although not finalized, the group is leaning towards a centralized air-cooled system with a visible distribution system doubling as a shade canopy for walkways
- Utilization of daylighting, state-of-the-art lighting components, and the lowest possible ambient lighting level/task lighting will reduce the lighting energy consumption to .75kWh/sf
- The photovoltaics will be attached to the existing grid to take advantage of the net metering program, if possible. The array could be placed at the WHB where it could double as a shade structure for the arena
- The bio-gas generation system does not appear to be feasible for this facility
- The facility will utilize re-usable washed hard plastic plates and cups, metal utensils, and 100% recycled/recyclable napkins
- The students will weigh and separate their garbage
- A composting program, possibly in conjunction with manure from the WHB, will be implemented for all organic waste and the paper napkins from the dining facility
- A recycling trailer will be on site and towed to the recycling facility when necessary
- Non-recyclable/non-compostable waste will be collected for pick-up. It is hoped that pick-ups can be reduced to once-a-month
- This facility will have one wastewater system that will utilize both mechanical and natural (plant material for nitrate uptake) treatment steps. The effluent will be used for irrigation and flushing toilets at the Dining area
- The 100,000 to 200,000 gallons of water storage necessary for fire protection could be located within the wall (or at another location) at the WHB facility
- The curriculum tie-ins to the actual facility and resource use consist of three items: observation through extensive metering of resource use, temperature variations, etc; resource optimization and competition between dorms; and exhibition of waste as a displaced resource

Monday, October 11th

Location: Hillel Foundation – Lower Level
Attendees:

Les Wallach	Line and Space, LLC
Henry Tom	Line and Space, LLC
Kevin Stewart	Line and Space, LLC
Bill Nelson	GLHN
Ted Moeller	GLHN
Bill Schlesinger	GLHN
Henry Johnstone	GLHN
Doug Stingelin	GLHN
Scott Marx	Gerard Hilferty and Associates
Don McGann	McGann and Associates
David Harsh	Rumsey Engineers
Pat Fleming	BLM
Tom Busch	BLM
Andy Walker	NREL
Ken Stockton	Arizona-Sonora Desert Museum
Paul Buck	DRI
John Sagebiel	DRI
Kim Blanc	DRI
Loretta Asay	CCSD

Introduction and Overview

Facilitator: Kevin Stewart, Line and Space

Objective:
Through dialogue and interaction among appropriate experts, establish specific renewable resource goals for the Red Rock Desert Learning Center and the Wild Horse and Burro Facility. This will include both quantitative (gallons, watts, etc.) and qualitative (interaction, experience, etc.) aspects along with associated implementation methodologies/ technologies (i.e. wind power, bio-gas generation, etc.).

After reviewing the objective of the workshop as stated above, Kevin referred to the agenda and explained that the attendees will participate in ‘outside-of-the-box’ idea-generation to:

- determine the various appropriate indoor environments
- establish baseline resource (water, electricity, gas, etc.) budgets/goals
- review LEED requirements
- identify passive thermal design strategies suitable for each building
- identify the supplementary active thermal design strategy
- review new low-energy lighting solutions
- finalize appropriate on-site power generation techniques
- identify techniques for recycling and re-use
- determine wastewater (greywater and blackwater) possibilities and their appropriate re-use strategy
- identify curriculum possibilities associated with resource conservation specific to this facility

Confirmation of Acceptable Indoor Environments

Facilitator: Bill Nelson, GLHN

The Indoor Environment of the facility, though it may vary from building to building, will be designed to meet ASHRAE standard 62 (a standard for indoor air quality that has not yet been adopted as code by Clark County) with the caveat that the system need not be operated at that standard, i.e. it can be backed off to meet the needs of the facility as described below. The justification for this decision is 2-part.

The first involves the fact that many municipalities are adopting this more strict ASHRAE standard as code. Although, Clark County has not adopted this standard as code, it is possible that they will do so in the future. In addition, there should be a high-level of comfort that meets the current Clark County School District standards. It would be short-sighted to build a facility that may have to be retro-fitted in the near future.

The second pertains to the climate. According to the psychrometric chart for Las Vegas, and the associated ASHRAE comfort zone within which 97% of the population will feel comfortable, a little under 2500 hours of cooling time and a little over 2500 hours of heating time will be required. Although the climate at Oliver Ranch varies from the climate of Las Vegas (it is slightly cooler with a bit more precipitation), the Las Vegas chart serves as a good baseline. The passive design strategies implemented can mitigate the extreme climate, but they cannot create stable and acceptable indoor environments year round. This may undermine the mission of the facility to create a bond between the student and the environment. Therefore, it is necessary to provide the framework for a comfortable environment year round although the students may need to participate in this, i.e. wear sweaters when it is too cold.

Determined acceptable indoor environments (Note: when unoccupied all spaces will be allowed to increase/decrease in temperature from ±90°F in summer to ±60°F in winter):

Space	Summer	Winter
Administrative:	78°F and 50%RH	68°F and 0%RH
Restrooms (outdoor):	outside air temp.	above freezing
Dorms:	82°F and 50%RH	60°F and 0%RH
Restrooms (adjacent to sleeping):	82°F, RH varies	70°F and 0%RH
Dining:	78°F and 50%RH	68°F and 0%RH
Kitchen:	82°F and 65%RH	65°F and 0%RH
Gear Room:	80°F and 50%RH	60°F and 0%RH
Flex-Labs:	78°F and 50%RH	68°F and 0%RH

(Note: The demonstration area may need to be better temperature controlled than the rest of the Flex-Lab due to equipment and animals)

Space	Summer	Winter
Art Room:	tempered microclimate	tempered microclimate
Instructor/Maintenance Housing:	78°F and 50%RH	60°F and 0%RH
Laundry:	85°F	55°F

Establish Baseline Resource Budgets/Goals

Facilitator: Bill Nelson, GLHN

To aid in this discussion, GLHN performed an energy analysis for a well-built and properly insulated facility similar to this one (without passive design strategies) meeting ASHRAE performance guidelines as a baseline comparison.
The following results are based on this analysis:

- The 3 largest consumers of energy are: Lighting @ 21.8%, Domestic Hot Water @ 21%, and Cooling @ 16.9%
- Overall energy consumption = 16kWh/sf

In addition, the new Clark County School District standard for energy use is 30,000Btu/sf/yr (or 8.8kWh/sf) which is for heating and cooling only.

Based on this information and knowledge that LEED awards points for a 60% reduction in energy use the following resource budgets/goals were established:

Lighting/Plug Load	2.5	kWh/sf
Thermal/DHW/Cooking	6	kWh/sf
Total	8.5	kWh/sf

The other main resource to be used on site is water. An earlier water budget (shown below) had been established by examining the residential per capita water use of various southwestern cities (Las Vegas = 230 gallons, Tucson = 107 gallons) and the per capita water use of a US Navy aircraft carrier (67 gallons):

Water 50 gallons per person per day

No budget was set for propane or other similar supplementary heating fuel.

Review LEED requirements

Facilitator: David Harsh, Rumsey Engineers

A 2 hour accelerated review of the LEED process and requirements for LEED points was conducted by David Harsh.

Some points that were gleaned from the presentation and the discussion include:

- A project can be LEED certified for campus or LEED certified for building(s)
- A project can file for LEED certification under the requirements in place when the project was registered or under the current requirements
- LEED is currently developing a regional criteria program but it has not been implemented yet (this program would offer more points for water conservation in the southwest than the 5 points currently available)
- The Additional Commissioning agent does not have to be from a separate company, but if they are employed by a company involved with the project, they must not have a working relationship with the project

Tuesday, October 12th

Location: Hillel Foundation – Lower Level
Attendees:

Les Wallach	Line and Space, LLC
Henry Tom	Line and Space, LLC
Kevin Stewart	Line and Space, LLC
Bill Nelson	GLHN
Ted Moeller	GLHN
Henry Johnstone	GLHN
John Jolly	GLHN
Doug Stingelin	GLHN
Scott Marx	Gerard Hilferty and Associates
Pat Fleming	BLM
Tom Busch	BLM
Andy Walker	NREL
Ken Stockton	Arizona-Sonora Desert Museum
Paul Buck	DRI
John Sagebiel	DRI
Kim Blanc	DRI
Loretta Asay	CCSD
Rick Watson	SNWA

Identify Passive Thermal System Design Strategies

Facilitator: Les Wallach, Line and Space, LLC

Les reviewed the conceptual site plan explaining the function of each building. The key to passive thermal design in the hot arid desert is an understanding of the sun and solar angles that allows you to shade in sync with the sun's position. Passive thermal design strategies for this project are those not involving the use of mechanical air-cooling/heating equipment (the idea of moving panels of insulation, or manipulating one's environment in some other way will be considered passive).

After this discussion, the individual buildings and their locations were reviewed in respect to possible passive thermal strategies. In addition, it was decided that the different buildings could represent different primary passive design strategies (i.e. earth integration, night-sky radiation, etc.) though they would all incorporate many of the same aspects. Following is a list of buildings and their respective possible design strategies (Note: this list was part of an idea-generation discussion and is not meant as a definitive assignment of techniques per building or as a limitation on other possibilities):

Building	Primary Passive Strategy	Additional Passive Strategies
Dorms:	Partial earth integration/earth roof	South-facing windows w/ thermal mass Shaded play areas between buildings Shade with PV's and hot-water collector Thermal chimneys with cooling towers Sleeping on roofs/decks (issues with boys/girls together)
Flex-Labs & Research:	Raised (due to floodplain) insulated boxes w/ movable insulation	South-facing windows w/ thermal mass Overhead roll-up doors "Snorkel" – pull cool-air from the wash

		Shade with PV's and hot-water collector
Dining/Kitchen:	Night-sky radiation (possibly only 1/3 of the roof would open/close) with thermal mass in summer and greenhouse effect in winter	Kitchen heat recovery Solar ovens Shade with PV's and hot-water collector Radiant heat Bead wall 'Isaac' solar ice maker
Administration:	Shade - 'Sombrero' strategy	Insulated panels at windows (has to be easy, maybe one large picture window in lieu of many smaller personal windows; panel could be on a track and would double as wall insulation when not covering the window; automatic panel)
Instructor Housing:	Earth integration	Solar hot water beds? Light wells with tempered microclimates

In addition to the aforementioned passive design strategies, Andy Walker introduced 'Solar Wall.' This system consists of a thin perforated metal panel (1mm diameter holes at 3mm on center) with a 4-6" air space behind it and a fan/damper assembly at the top of the air space. The air heats up on the surface of the panel and is drawn into the air space behind the panel by the fan which distributes the air to the ventilation system (when not needed, the damper is opened and the hot air in the plenum is ventilated) for use in conjunction with meeting ventilation/outside air requirements.

Identify Active Thermal System Design Strategies

Facilitator: Bill Nelson, GLHN

Per the earlier energy analysis performed by GLHN, they determined that a savings of 46% in energy cost would result from utilizing evaporative cooling techniques in lieu of compressor/condenser type systems. However, evaporative cooling would consume approximately 12 gallons per person per day (averaged across the year) of water, varying from zero use during winter months and 7000 gallons per day during peak summer months.

The question is not necessarily which is more valuable, water or electricity, but rather is it acceptable to utilize approximately 500,000 gallons of water per year for evaporative cooling that could not be reclaimed or reused in any way?

Although no concrete decision was reached, the participants were leaning towards utilizing state-of-the-art compressor/condenser type technology fed from the photovoltaic system. Whether or not the compressor/condenser type technology would be part of a larger central system or would consist of smaller package units (one or two for each building) was not decided. The education possibilities associated with a larger central system clearly defining an area where water is cooled or heated, a visible system of distribution (exposed piping run overhead between buildings that doubles as a shade component along walkways), and small fans which show that the air blowing into spaces is cooled/heated by blowing air across a coil that is cooled/heated by the water seem easier to understand than trying to explain a small package unit.

In addition, the maintenance costs associated with each system must be considered. Any type of evaporative cooling (that is considered efficient) results in system water with high-particulate content and subsequently, depending upon rate of bleed-off, mineral scale on equipment. The smaller package units have a lower initial maintenance cost but will need replacing every 12-15 years. The larger central a/c unit will need replacing every 30 years. A centralized 2-pipe fan-coil system with an easily accessible exterior service door would ease maintenance effort.

GLHN will perform a life-cycle cost analysis comparing the 3 cooling/heating strategies discussed over 25 years. The package units will be less costly for the first 20 years, but it is thought that after that period of time a central system may be considered the most efficient.

Identify Artificial and Natural Lighting Strategies

Facilitator: John Jolly, GLHN

As shown in the energy model developed by GLHN, lighting is responsible for 21.8% of energy use (the largest of any category). By utilizing state-of-the-art lighting design strategies in conjunction with a lowest possible ambient lighting level/task lighting system, it is believed that the facility can reduce energy consumption by lighting to .75kWh/sf.

John presented many of the advances being made in low-energy use lighting.

- The use of T-8's, T-5's, and T5HO's are excellent for field lighting. In lieu of using dimmable ballasts (with their additional cost) a strategy employing rows (each with their own switch) of these fixtures parallel to a daylighting source in conjunction with light level monitoring and automatic switching would allow for the students to see the effect that daylighting has on its space and the fluctuations in daylight levels corresponding to fixtures turning on/off
- Compact fluorescents, Halogen fixtures, and LED retrofit fixtures provide excellent task lighting, and offer individual control of the environment. Widespread use of the new LED technology was not recommended by John as the technology is still evolving and standards have yet to be developed between different manufacturers.
- Small solar powered LED lights would be an excellent choice for path lighting, etc.

Some of the daylighting strategies discussed include: narrow buildings that will allow daylight to permeate throughout the interior, north clerestories in conjunction with operable windows for ventilation, clerestories with the use of reflective surfaces to bounce light deep into the building, a product called Okasolar (which consists of a series of parabolic mirrored louvers embedded between panes of glass) that directs the daylight to the ceiling of the interior space for a diffuse ambient level, and selectively permeable glass (different wavelengths of light are not allowed to pass through) but this may be too expensive for consideration.

Review On-Site Power Generation Strategies

Facilitator: Ted Moeller, GLHN

Four on-site power generation techniques and their implementation were discussed: photovoltaics, solar hot-water production, wind power, and bio-gas generation.

The project budget contains funds for up to 200KW of photovoltaic generated electricity. Based on GLHN's energy analysis, a fixed PV array would meet the standard building's energy needs for all but 2 months of the year, and a single-axis tracking PV array would produce approximately 150% of the energy needed. These figures do not take into account the facility's energy budget/goal of 8.5kWh/sf which is almost half of the 16 kWH/sf associated with GLHN's energy model. Therefore, this facility may be able to reduce the size of the PV array by more than half to meet the facility's peak demand. If the net metering program (one can sell electricity back to the grid at the same rate that one is buying it) can be utilized, the facility may be able to feed any excess electricity generated into the grid. This system would eliminate the need for battery storage (costly and problematic in temperatures above 80°F), and would establish this facility as an energy producer for the grid. The possibility of placing the PV array at the WHB where it could double as a shade structure above the arena exists due to its location adjacent to existing power lines.

The sun's energy can also be used to directly generate hot water which is stored for later use. This hot-water can be utilized for the domestic hot water system (showers, lavatories, etc.), and some indoor heating. However, sanitary dishwashing will require supplementary heating as will the indoor heating requirements during some of the colder periods (this will be achieved with propane or compressed natural gas). In lieu of using the traditional flat-plate solar collectors normally associated with hot water production, the 'Solar Wall' system previously discussed may be adapted for hot water production.

We believe, wind power, although interesting, is not a dependable possibility at the Oliver Ranch site. Typical rule of thumb is that if the wind has not influenced the direction of tree growth (i.e. leaning trees) then there is not a dependable wind power source of great enough magnitude. However, the simplicity of the system would be easily understandable for the students: the wind turns the rotor which in turn generates electricity, or pumps water directly.

Because of the amount of raw material needed for an efficient bio-gas generation system producing gas of any usable magnitude, the bio-gas generation system does not appear to be feasible for this facility (even when considered in conjunction with the manure produced at the WHB). The raw material that would have been used for bio-gas generation will be discussed in the zero-discharge site and wastewater discussions.

It is important to make the on-site power generation techniques demonstrable to the students. This could be achieved through large-scale fields of arrays and flat-plate collectors (or similar), or through smaller systems associated with each building (this would generally require rooftop equipment, but could be designed to be accessible to all). Large fields of arrays may be more appropriate for connecting the students to simple concepts: this is where electricity is generated and this is where hot water is generated, this is the size of equipment necessary for the facility, and this is the distribution network. In addition, the large fields could be tied into a large central cooling/heating system. However, the possibility of having some smaller scale hands-on demonstration areas would also be a nice opportunity for the children.

The Art Room could be completely disconnected from the rest of the facility. It would consist of a stand-alone system using wind power (either for electricity production or direct water pumping to a solar heater) in conjunction with a small PV array. All water to be used here would be brought by the students.

Wednesday, October 13th

Location: Hillel Foundation – Lower Level
Attendees:

Les Wallach	Line and Space, LLC
Henry Tom	Line and Space, LLC
Kevin Stewart	Line and Space, LLC
Bill Nelson	GLHN
Ted Moeller	GLHN
Bill Schlesinger	GLHN
Scott Marx	Gerard Hilferty and Associates
Don McGann	McGann and Associates
Pat Fleming	BLM
Tom Busch	BLM
Ken Stockton	Arizona-Sonora Desert Museum
Paul Buck	DRI
John Sagebiel	DRI
Kim Blanc	DRI
Jeanne Klockow	UNLV
Rick Watson	SNWA

Zero-discharge Site (includes recycling)

Facilitator: Bill Nelson, GLHN

One of the main issues associated with recycling at this facility includes the dining utensils/plates/etc. An efficient commercial kitchen uses approximately 3 gallons of water per meal (this includes preparation, cooking, and cleaning). Bill Nelson, believes that number could be reduced to 1 gallon per meal. When examining this issue for the Restaurant at the Arizona-Sonora Desert Museum, Line and Space looked at a study done by the Smithsonian for the Air & Space museum which determined that foam dining utensils/plates/etc. were the most sustainable because they are endlessly recyclable from one to the other. However, water and energy are used in the recycling process. Additionally, there is not a current recycling program serving this area of Las Vegas. Students may walk away from a facility using recyclable products that are thrown away at every meal with the wrong message. Therefore, the facility will utilize re-usable, washed, hard plastic plates/cups (made from recycled material)/metal utensils, and 100% recycled/recyclable paper napkins in a family-style dining setting.

Upon finishing their meals, the students will weigh their garbage and separate it into animal waste, compostable waste (possibly further separated into edible vs. non-edible, see next paragraph), recyclable paper products, liquids, and waste.

The paper napkins and non-animal food waste would be composted (the ‘edible’ portion of the garbage could be separated out from the other waste and given to Bonnie Springs to feed their animals) possibly in conjunction with manure from the WHB. This compost could be utilized in the greenhouse, for revegetation of lands, and could be distributed to the classes when they leave (not the compost material that they generated, but the final compost from a previous classes visit) in proportion to what they generated while on site (the amount would probably be two or three cubic feet).

A trailer with containers for all other recycled materials brought onto site (cardboard, aluminum, plastic, etc.) would be provided and towed to the recycling facility when full (possible by one of the electrical vehicles charged by the solar power station). The students would participate in this process.

Rather than creating a small landfill or introducing additional solid waste into the wastewater treatment system, the animal food waste, if not given to Bonnie Springs for feed, would be disposed of off-site in conjunction with other non-recyclable waste. The goal of the facility would be to minimize pick-ups for the sanitary landfill to once a month, or more, instead of the almost daily pick-up normally associated with a facility this size.

Identify Potable Water and Wastewater (greywater/blackwater) Possibilities

Facilitator: Bill Schlesinger, GLHN

The potable water for the facility will most likely come from an on-site well. Rainwater from harvesting requires some treatment to become potable, greywater requires additional treatment, and blackwater requires extensive treatment. It is assumed that by reducing the consumption of water to less than 50 gallons per person per day, it will not be necessary to reuse water for potable purposes.

Rainwater will be harvested on site for use as irrigation.

It is possible to have 2 separate wastewater systems: greywater and blackwater. However, there are some issues with separating the greywater from the blackwater. Greywater, if stored, results in odors and hygienic concerns. The amount of blackwater produced at this facility may not create enough of a liquid to solid ratio for proper treatment. Research by Bill Schlesinger shows that existing facilities with this separation believe that integrating the 2 systems into a single wastewater system is the best approach. Therefore, this facility will integrate the 2 systems into one system, but greywater will be metered at its source. This one wastewater treatment system will utilize both mechanical and natural (plant material for nitrate uptake) treatment steps similar to the system used at Ethel M in Las Vegas to produce an effluent that will be used for irrigation and for flushing toilets at the Dining Hall Restroom. The students will not have hands-on access to this system due to hygienic concerns.

The irrigation will be used for tempered micro-climates, establishing plant species on the grounds, growing plants in the greenhouse, and revegetating disturbed areas of land. Research will need to be done in respect to the level of treatment for the effluent required for the kids to participate in the irrigation process. It is assumed that the irrigation water in some areas can be buried/fixed, but it will need to be exposed and moveable in other areas such as the revegetation plots.

Additionally, a large amount (100,000-200,000 gallons) of water for the fire protection system will need to be stored on-site. The use of greywater for this system is not desirable. The storage could possibly be located at the Wild Horse and Burro Facility within the wall of the ‘Wall Concept.’ This location (which is the same height as the top of the cistern hill) would provide some static head to the system which would need to be boosted by a UL listed fire pump (possibly propane burning). It will also be part of the view impact from the Highway associated with the WHB and not a new disturbance.

Curriculum Possibilities
Facilitator: none – general discussion

The main curriculum tie with the actual resource use of this facility comes from multiple sensoring/monitoring devices embedded in the system and the construction itself.

The students will gather data on their usage of water, electricity, etc. and will analyze it themselves. This data will be displayed and used to compete with the other classes on a dorm to dorm basis. The key is to establish a baseline of optimized resource use, not to minimize the use of water or electricity at the expense of hygiene, etc.

The students will be able to visit the PV array, hot-water production areas, cooling/heating plant, etc. in appropriate student-proof zones (catwalks, or similar with no knobs/levers/buttons/etc.).

The curriculum tie-ins to the actual facility and resource use consist of three items: observation through extensive metering of resource use, temperature variations, etc; resource optimization and competition between dorms; and exhibition of waste as a displaced resource

end of workshop